2 Aircraft

Fig. 1. N3R in flight during a research mission.

Over the last ten years, N3R has been used by the National Oceanic and Atmospheric Administration's (NOAA) Air Resources Laboratory (ARL) in a number of air-sea interaction research studies. The differences between N3R and that of a standard airplane are obvious (Fig. 1). Far more than just being visually striking, these design features are ideally suited for high-fidelity turbulent flux measurements, especially at low altitudes.

The LongEZ was designed in the early 1980's by Burt Rutan as a high-performance sport aircraft. N3R is a custom-built aircraft licensed by the Federal Aviation Administration (FAA) under an experimental amateur-built airworthiness category. It is a safe and reliable aircraft with exceptional performance characteristics. Unlike most aircraft that are constructed with metal, N3R is fabricated from light-weight, high-strength fiberglass and foam composite that is resistant to structural fatigue and corrosion. Another important feature is that the engine is mounted on the rear of the airframe. The large main laminar-flow wing is set back further than that of conventional aircraft. Vertical winglets found on either end of the main wing enhance aircraft lift. A smaller second wing (canard) is found near the nose of the aircraft. This forward lifting surface is designed to increase aircraft stability and to prevent the main wing from stalling.

An important characteristic of an aircraft with a pusher engine and a canard is that it responds to turbulence far less than conventional aircraft with the same wing loading (weight per unit area). Since the canard contributes to both lift and stability, it can be heavily loaded relative to the main wing. For conventional aircraft with a rear-mounted elevator, an upward wind gust will tend to make the aircraft pitch up. This increases the lift generated by the wings and amplifies the aircraft response to an upward wind gust. In contrast, canard aircraft have their elevators forward of their center of gravity (CG). The same upward wind gust will push the canard elevator up which results in a compensating downward pitch response. Aircraft pitch response to either upward or downward wind gusts is opposed to the gust direction, thus giving canard-type aircraft their superior turbulent response characteristics. A canard aircraft is also stall-resistant. As the angle of attack on the airplane is increased, the canard loses lift before the main wing. This causes the nose to drop, which decreases the angle of attack, thereby providing automatic stall recovery without allowing the main wing to stall.

The unique aerodynamic design features of N3R make it ideally suited for making high-fidelity turbulence measurements with minimal flow distortion at low altitudes (~ 10 m) and slow aircraft flight speeds (~ 50 m s^{-1}). The small low-drag airframe and rear-mounted pusher engine have clear advantages for minimizing flow distortion and exhaust contamination (Crawford and Dobosy 1992). Instruments mounted on the aircraft nose avoid flow distortion, engine vibration, and engine exhaust. On N3R, the wind measurement probe is five wing-widths (chord lengths) ahead of the canard. The resulting flow distortion is extremely low compared to other aircraft (Crawford et al. 1996).

The utility of N3R is illustrated by its impressive specifications and performance (Table 1). There are few aircraft that will carry its own weight as payload. Typically, N3R will fly a research mission at 50 m s^{-1} consuming fuel at a rate of only 11 kg hr^{-1}. Its fast cruise speed and long-range allow it to reach anywhere in the world. Because of its classification under FAA's experimental category, modifications can be made easily. N3R has been modified for scientific research with a larger engine, redundant high-output alternators, extended fuel tanks, and hard-points and port holes for instrument mounting. Fiberglass construction allows flexibility in modifying the airframe to mount sensors and instrument pods.

Table 1. N3R specifications.

Engine	Lycoming O-320 160 HP
Seats	2
Electrical	72 Amp @ 12 VDC
Fuselage Length (with probe)	5.0 m (5.6 m)
Wing Span	8.5 m
Wing Area	10 m^2
Canard Span (Chord)	3.7 m (0.38 m)
Propeller Diameter	1.80 m
Weight (empty)	430 kg
Payload	370 kg
Fuel Capacity (with aux tank)	200 kg (300 kg)
Range (extended)	3300 km (3800 km)
Ceiling	8000 m
Endurance	10 - 18 hr
Cruise Speed	90 m s^{-1}
Stall Speed	25 - 30 m s^{-1}
Fuel Use @ 50 m s^{-1} (90 m s^{-1})	11 kg hr^{-1} (20 kg hr^{-1})

A number of important safety features have been incorporated into N3R. A 406-MHz Emergency Locator Transmitter (ELT) can send a distress signal via a NOAA Geostationary Operational Environmental Satellite (GOES) to a U. S. Coast Guard station or other rescue facility within seconds of activation. In the event of a catastrophic airframe or engine failure, a solid rocket ballistic parachute can be deployed in ~ 1 s. The parachute, which is attached to the airframe, can safely lower the aircraft and pilot to the surface. A four-point harness and foam impact seat are capable of withstanding a 40-G impact. The auto-pilot is used to reduce pilot stress and fatigue for long flights. Routine radio communications are maintained with a ground-station on a regular basis. Other safety features include a life jacket, survival suit, inflatable raft, flare gun, signal mirrors, flashlights, chemical light sticks, and emergency rations.